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Glischroderma Fuckel

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Abstract—*Glischroderma* and its type species *G. cinctum* are redescribed and illustrated with respect to their original description. Subsequent collections of the species show significant divergences, possibly distinct species, which should be investigated from fresh material. American collections referred by Korf to *Glischroderma* based on the presence of gel and similar conidiogenesis are shown to be distinct from *Glischroderma* in a number of characters, and a 1999 phylogenetic study has related that anamorph to *Pachyphlodes pfisteri*. *Glischroderma* is also distinguished from *Ostracoderma* by decisive characters.

Keywords—*Chromelosporium, Lycoperdellon,* peridium, *Pezizales,* pore

Introduction

In 1973, when describing the *Botrytis* and *Botrytis*-like genera of conidial fungi, Hennebert included *Ostracoderma* Fr. and *Glischroderma* Fuckel; both supposedly produced dichotomously branched *Chromelosporium*-like conidiogenous hyphae producing abundant one-celled simultaneous conidia on denticles, but contained inside a peridium similar to the peridium of some gasteromycetes, such as *Lycoperdon*. The interpretation of *Ostracoderma* by Juel (1920) and Hughes (1953, 1958) was corrected by transferring the non-peridiate species to *Chromelosporium* Corda, with *Ostracoderma* [*ostracos* = shell] remaining monotypic with the peridiate *O. pulvinatum* Fr. originally classified by Fries in the *Trichodermataceae*, close to the hyphomycetes. Although no type material is available for *Ostracoderma pulvinatum*, Hennebert (1973) regarded the peridiate genus *Lycoperdellon* Torrend as a possible synonym. The genus *Glischroderma* was kept separate for taxa with verrucose spores, absent in *Lycoperdellon*, a character ignored by both Fries and Fuckel but noted by Rea (1913).

In 1994 Richard P. Korf and his mycology class collected a specimen in the valley of Lost Lodge in New York State referred to *Glischroderma* based on its abundant gel [*glischros* = viscous] and *Chromelosporium*-like conidiogenesis; a study of the collection was initiated shortly thereafter but unfortunately interrupted for a long time. My study of the Korf collections preserved in CUP herbarium, here presented with reference to the type material of *Glischroderma cinctum* from herb. G, is dedicated to Korf's memory.

Materials & methods

This study is based on the examination of herbarium specimens from the herbaria of the Botanical Garden of Genève, Switzerland (G); of the Department of Plant Pathology, Cornell University, Ithaca, NY, USA (CUP); and of the Botanic Garden, Meisse, Belgium (B). A 1960 Olympus FH microscope with positive low phase contrast objectives was used for the microscopic examinations.

Taxonomy

Glischroderma Fuckel, Jahrb. Nassauischen Vereins Naturk. 23–24: 34, 1870.

> Original description: Peridium hemisphaericum, tenax, persistens, demum [at length] in centro irregulariter fissum, e floccis tenuissimis contextum, furfuraceo-villosum, basi mycelio tenuissimo cinctum, sporidiis concervatis, minutissimis, globosis, floccis destitutis [lacking hyphae] repletum.
>
> Obs. Peridium in statu juvenili siccum, album, contextu fibroso, dein in centro ampliatum [enlarged, extended], argillaceum, annulo albo e peridio juvenili represso orto [born limited from the young peridium] circumdatum.
>
> Type species: *Glischroderma cinctum* Fuckel

Glischroderma cinctum Fuckel, Jahrb. Nassauischen Vereins Naturk. 23–24: 35, 1870 Plates 1, 2, 3b,c, 4b, 5a

> Original description: 1. *G. cinctum* Fuck. F.rh. 162. – Peridio hemisphaerico, usque ad semiunciam diametro transversali, argillaceo, cum annulo albo fibroso cincto, ore destituto [lacking a pore], sed demum irregulariter in centro fisso, sporidiis globosis, uniguttulatis, ca. 4 Mikr. diam., argillaceo-rubellis. Tab. I. Fig. 18 a. Fung. Nat.magn. b. Sporid. [see Plate 2a]
>
> Ad verlassenen Köhlerstellen an Köhlenstückchen, sehr selten, im Herbst. Unweit der Arnsbacher Brücke, im Winkler Wald.
>
> Etymology; Greek *glischros* = Latin *tenax* = viscous, sticky, adherent, gripping.

Conidioma peridiate, hemispherical, pulvinate, not constricted at the base when mature, ≤9 mm diam. as dried, larger when fresh and mature ("ampliatum"), arising from a limited ("represso") subiculum adherent to the charcoal substrate.

Subiculum white, giving rise to the young fruitbody (Fuckel) and exceeding by 1–2 mm the rind of the mature peridium, made of a network of hyaline septate branched hyphae, 3.5–5.5 µm diam., here and there up to 12 µm diam.

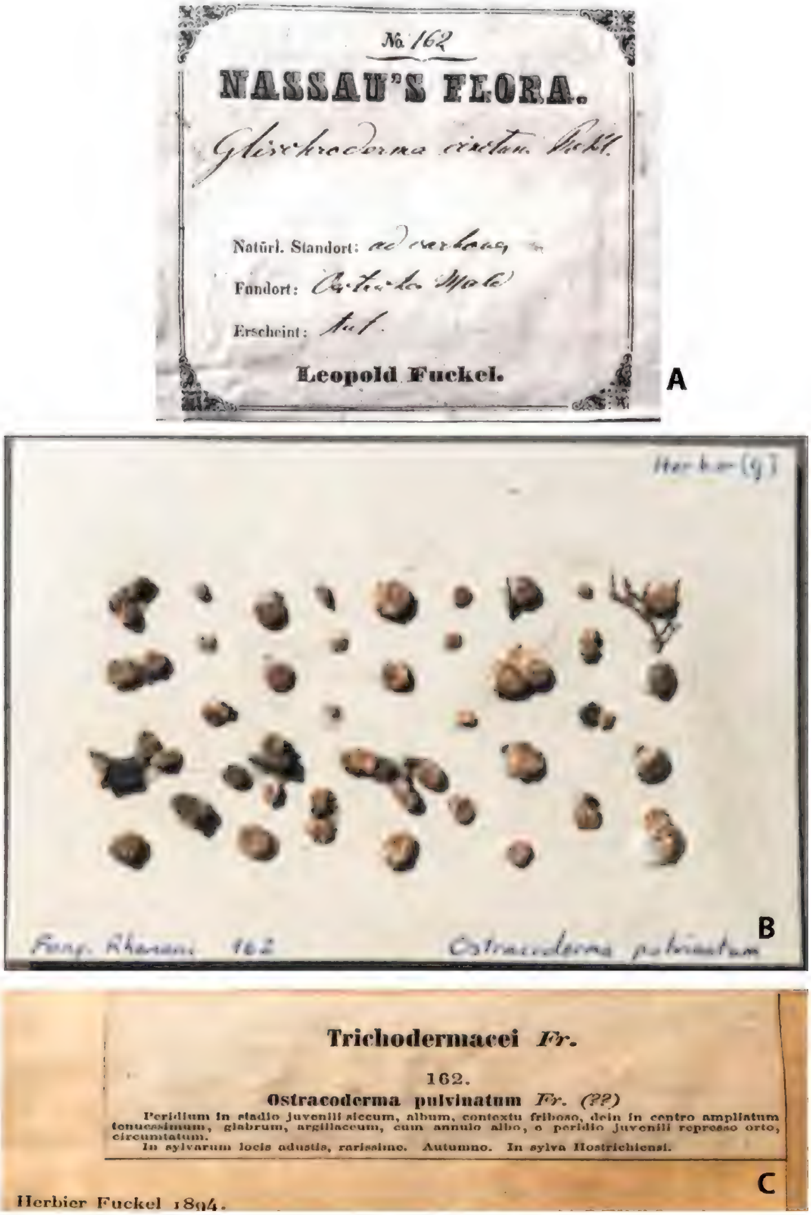
Peridium persistent but fragile and easily fissured, with no central pore ("ore destituto"), ocher-grey to argillaceous brown in color as dried, externally comprising densely interwoven sinuous, septate, hyaline hyphae, and internally comprising a lacunar network of right- or broadly angled branched septate hyaline hyphae, 3.5–5.5 µm diam. Peridium at first dry when young (Fuckel), becoming later sticky ("tenax") or glutinous. According to Fuckel, the peridium dehisces through an irregular split at the center ("irregulariter in centro fisso") with no central pore observed.

Conidiogenous hyphae internal, hyaline, septate, 2–6 µm diam., seen as small collapsed pieces on the dried material. The agglutination of the conidia around pieces of hyphae (a few bearing denticles) on the microscopic slide and the regular size of the conidia suggest a conidiogenesis similar to that of *Chromelosporium* on irregular repeatedly bifurcate, coralloid, branched hyphae that produce very abundant conidia borne more or less simultaneously on minute denticles remaining visible all along the hypha, after which the hyphae collapse and almost disappear ("floccis destitutis").

Conidia holoblastic, globose, 3.5–4.2 µm diam., hyaline, pale yellow cream in mass, often sticking together as initially produced, the wall 0.5 µm thick and minutely verrucose.

Holotype specimen examined: Fuckel, Fungi rhenani 162, 1763 labelled by Fuckel: «N°162 Nassau's Flora - *Glischroderma cinctum Fuckel* - Natürl. Standort: *ad carboner* - Fundort: *Oestrika Wald* - Erscheint: *Aut.* (scripsit Fuckel) - Leopold Fuckel» [Plate 1a]. On an old fireplace on debris of charcoal, very rare, in autumn, near the bridge over the Arnsbach, in the Winkler Forest, (near Oestrich, Germany). Overlabeled in 1894 when incorporated into the Herbier Barbey-Boissier «*Ostracoderma pulvinatum* Fr (?) Peridium in stadio juvenili siccum, album, contextu fibrilloso, dein in centro ampliatum, tenuissimum, glabrum, argillaceum, cum annulo albo, e peridio juvenili represso orto, circumdatum. In sylvarum locis adustis, rarissime. Autumno. In sylva Hostrichiensi.» [Plate 1c], a conflation of Fuckel's separate published generic and specific descriptions of *Glischroderma cinctum* (in herb. G). The holotype specimen consists of fifty fruit bodies from 1.5 to 9 mm in diam., glued on a piece of cardboard from loose original material in charcoal debris and recently overwritten «Herbier (G), Fungi rhenani 162, *Ostracoderma pulvinatum* Fr.» [Plate 1b]. A small envelope containing charcoal debris and small pieces of the fungus is included.

Comments—The schema by Hennebert (1973, fig. 10) illustrating the fruit body of *Glischroderma cinctum* is misleading in that it reflects the more or



№ 162

NASSAU'S FLORA.

Glischroderma cinctum Fckl.

Natürl. Standort: ad carbones

Fundort: Oestricher Walde

Erscheint: Aut.

Leopold Fuckel.

Trichodermacei *Fr.*

162.

Ostracoderma pulvinatum *Fr. (??)*

Peridium in stadio juvenili siccum, album, contextu friboso, dein in centro ampliatum tenuissimum, glabrum, argillaceum, cum annulo albo, e peridio juvenili represso orto, circumdatum.

In sylvarum locis adustis, rarissime. Autumno. In sylva Hostrichiensi.

Herbier Fuckel 1894.

Plate 1. A–C. *Glischroderma cinctum* type material (in herb. G).

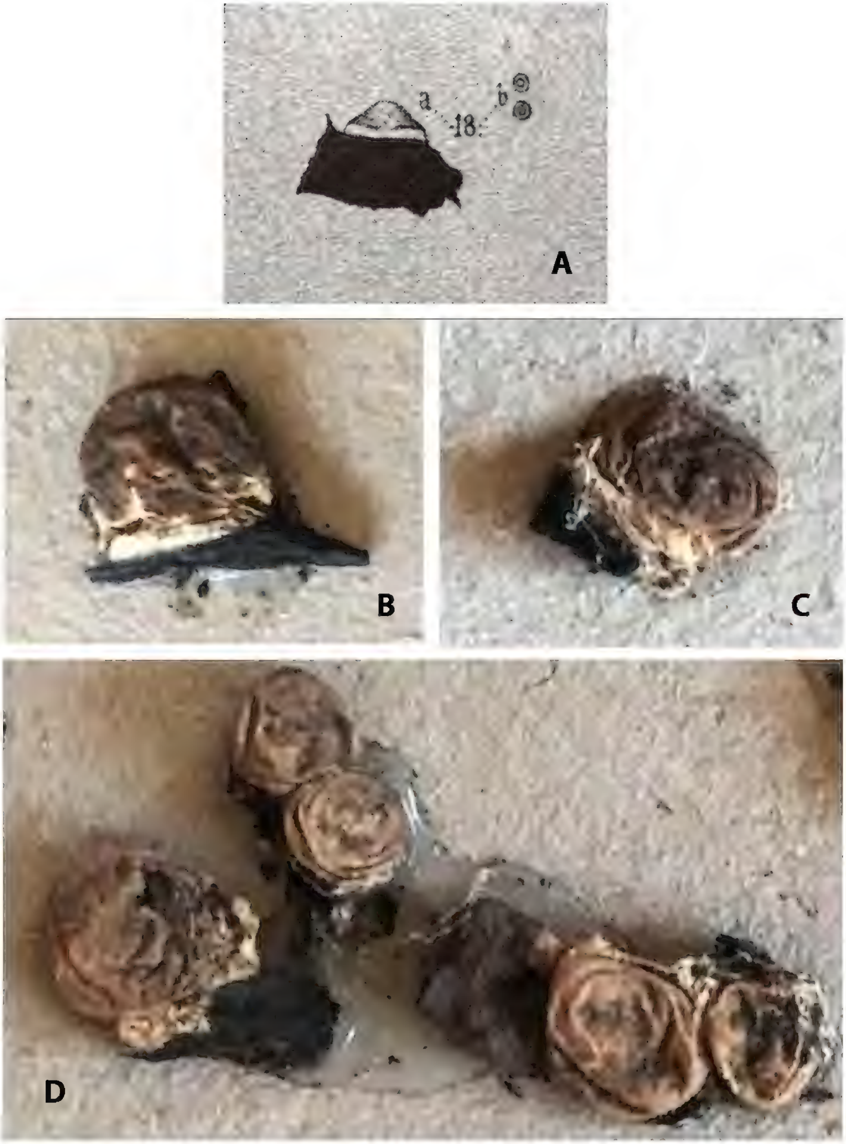


Plate 2. *Glischroderma cinctum*: A. Fuckel (1870, Plate 1, fig. 18): a. the fruit body, b. the spores; B–D fruit bodies of the type material, two in side view (showing the flattened position on a cushion of white mycelium on the black charcoal substrate) and five in top view (showing some extension of the white subiculum and absence of a pore in the peridium).

less pedunculate fruitbody as drawn by Malençon (1964, fig. 1.D) for a more mature fruitbody instead of the "broadly sessile" fruit body sitting on a limited white hyphal subiculum noted by Fuckel (1870) and Rea (1913).

Another divergence from Fuckel in Hennebert's (1973) schema is the presence of a "well defined central pore" based on the Rea (1913) and Malençon (1964) interpretations of *Glischroderma cinctum*; Fuckel denied the presence of a pore.

Glischroderma* aff. *cinctum PLATES 3A, 5B

Differs from *Glischroderma cinctum* by: (1) the dehiscence developing from a central darker circular zone, scarcely conspicuous, that delimits a star-shape splitting of the peridial wall to form the lips of a central pore; (2) the hyphal structure of the peridium seen *in siccum* lacking the compacted hyphal surface observed in the type of *G. cinctum* (PLATE 3B).

PERIDIUM made of a lacunar (crisscross) network of hyphae similar to the peridium internal context of the *G. cinctum* type specimen. SUBICULUM hyphae 3.5–6 µm diam., septate, loosely interwoven, branched at broad or right angles, sometimes at opposite sides and enlarged up to 12 µm at branching. CONIDIOGENOUS HYPHAE are 6–8 µm diam., branching more or less dichotomously or coralloid, producing conidia on conspicuous denticles all along their side. A *Chromelosporium*-like conidiogenesis is deduced of the typical branched agglutination of conidia on pieces of collapsed the hyphae. CONIDIA are holoblastic, globose, 3.5–4.2 µm diam., the walls thin and minutely verrucose showing 4 to 6 warts in cross section,

SPECIMEN EXAMINED: **BELGIUM, ST. HUBERTUS FOREST, Baconfoy:** as *Catastoma circumscissum* Berk. & M.A. on burnt ground between mosses under *Abies excelsa* [= *Picea abies*], Oct. 1912, Herb. E. Bommer & M. Rousseau, in herb. B, redetermined as *Glischroderma cinctum* by V. Demoulin, 1966.

COMMENTS—Malençon (1964) describes the formation of the central pore as observed in the above specimen. Fuckel describes his species as "ore destituto, sed demum irregulariter in centro fisso", lacking any apical pore but splitting irregularly in the center. None of the fruit bodies in the *G. cinctum* type material shows such a pore or darkened circular center that could become a pore at the center of the peridium. The stickiness of the peridium described by Fuckel as 'tenax' has been observed only by C. Rea on fresh collections in England, but not by G. Malençon in Morocco. Would that observation or the character itself be circumstantial?

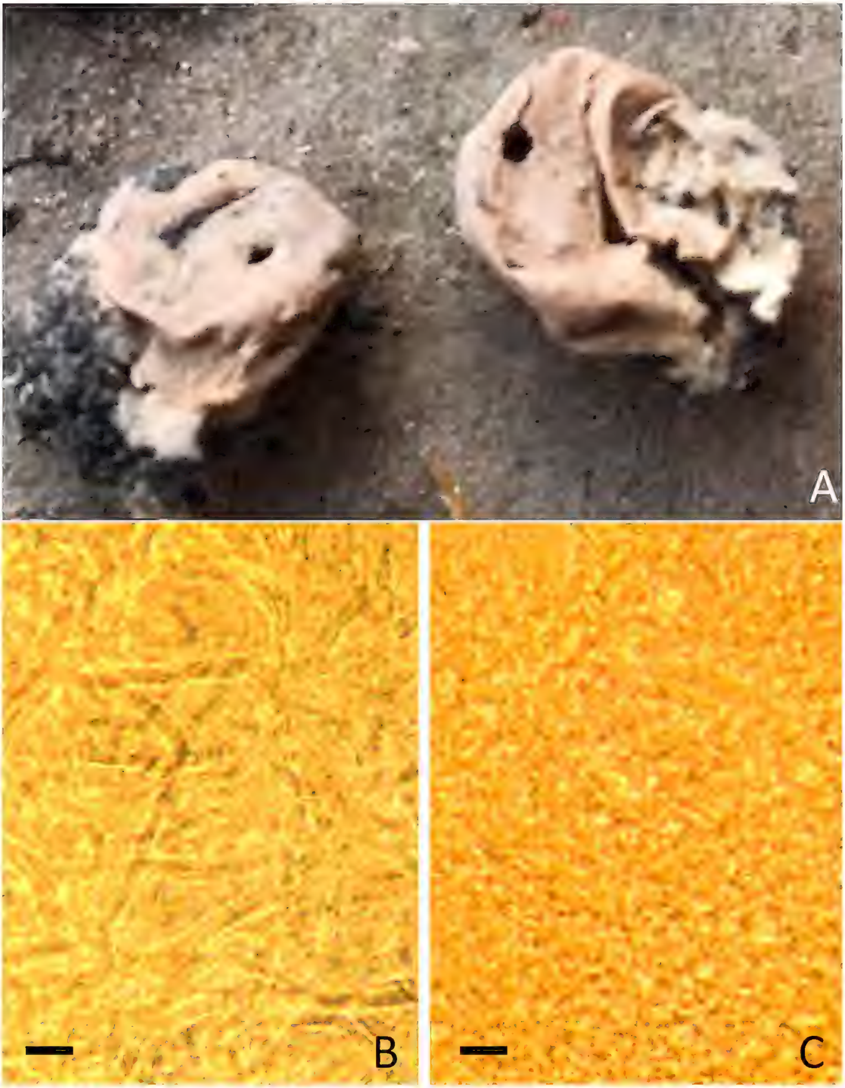


Plate 3. A. ***Glischroderma* aff. *cinctum*** (herb. B, coll. M. Rousseau in Belgium) showing central apical pore; B, C. ***Glischroderma cinctum*** (type): hyphal structure of the peridium, the context (B) and the compact surface (C) not observed in *G.* aff. *cinctum*. (Scale bars: B, C = 5 µm)

Glischroderma aff. *cinctum* might represent a second species of *Glischroderma*. This possibility should be investigated from fresh collections and their DNA analysis.

Pachyphlodes pfisteri Tocci, M.E. Smith & Healy, Ascomycete.org. 7(6): 360, 2015.

ANAMORPH (MITOSPORIC STATE) PLATES 4A,C, 5C

MYCELIAL MAT not peridiate, flat, irregularly extended, ≤3.5 cm diam., not constricted at the edge, appressed at the substrate, entirely or partially covered of a translucent glutinous liquid gel.

MYCELIUM white, a net of loosely interwoven broad hyphae, 5.3–8.5 µm, (often ≤17.5 µm) wide, generally straight, branching at wide or right angles, septate, often fasciculate (synnematous) up to 20 mutually anastomosing hyphae, the fascicles of hyphae becoming erect, sporulating along their side, bending in the superficial gel layer, when drying forming a translucent shiny and somewhat rose orange pellicle or membrane, persistent and brittle, enclosing superficial loose and fasciculate hyphae and covering the entire surface or only a part of the hyphal mat.

CONIDIOGENOUS HYPHAE hyaline, septate, most often arising from the side of erect fasciculate hyphae (synnemata) branching at right angles repeatedly and shortly, branches soon bifurcating in a very irregular dichotomous or coralloid way, branches covered at maturity all along their length with abundant conidia born more or less simultaneously on minute 1 µm long denticles that remain visible of the hyphal cell after release of the conidia.

CONIDIA (mitospores) holoblastic, globose, hyaline, white to pale yellow in mass, 4.2–6.5(–8) µm diam., with a wall 0.5 µm thick and conspicuously verrucose all over.

HOLOTYPE: FH (MES-306); reference sequence, GenBank JN102474 (Healy et al. 2015).

SPECIMENS EXAMINED: **USA, NEW YORK STATE: Alpine,** at the north end of Lost Gorge (Hendershot Gulf), (1) CUP 62646, as *Glischroderma cinctum* Fckl. (in Korf's handwritten notes *Glischroderma ?cinctum)* on decaying wet leaves col. Mycology 319 Class, id. R.P. Korf, 14.IX.1994, (2) CUP 63540, as *Glischroderma americanum*, on rotten wood of birch, col. J. Haudenshield, id. RPK, 20.IX.1995, (3) CUP 63647, on wet leaves, col. RPK, Lizoň et al. id. RPK, 19.VIII.1997. **Ithaca,** Coy Glen, (4) south slope nr Elm St, CUP 62652, on soil, leaves, enmeshing debris, col. P. Lizoň, id. RPK 12.X.1994, (5) CUP 62653, on mossy log. col. P. Mullin, id. RPK, 12.X.1994 (one fruit body 13x25 mm), (6) CUP 62654, idem as CUP 62653. **Malloryville,** Eames Bog, (7) ½ way up north slope, CUP 62650, as *Glischroderma* n. sp., on leaves, col. id. RPK, 5.X.1994. GenBank sequence of anamorph AF133160 (Norman & Egger 1999), (8) ¼ way up north slope, CUP 62651, as *Glischroderma* n. sp., on leaves, twigs, pieces of bark and base of ferns, col. KT. Hodges, id. RPK, 5.X.1994 [PLATE 4A] sequenced AF133160 by Norman & Egger (1999). (9) CUP 63648, on wet wood, col. RPK, Lizon et al., id. RPK, 19.VIII.1997. (10) CUP 63695, on duff, col., id. RPK, 16.IX.1998. [All specimens, (8) excepted, were annotated by Rosanne Healy (8.VIII.2013) as having spores and hyphae similar to *Pachyphlodes (thyselli)*-mitospore mat.]

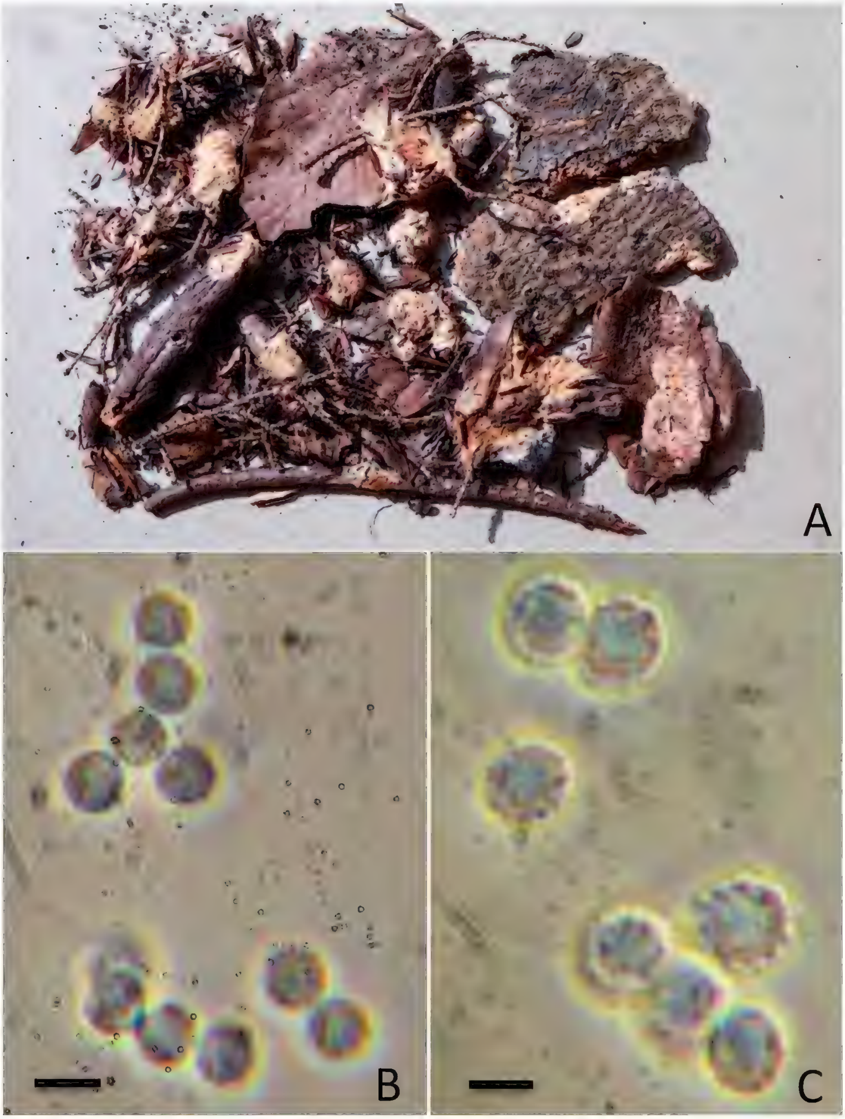


Plate 4. A. ***Pachyphlodes pfisteri*** (CUP 62651): epigeous anamorph of the truffle, coll. K.J. Hodges & R.P. Korf, NY State, USA; B. ***Glischroderma cinctum*** (type): conidia; C. ***Pachyphlodes pfisteri*** (type): conidia. (Scale bars: B, C = 5 µm)

Comments—*Pachyphlodes pfisteri* differs from *Glischroderma cinctum*, as Korf noted, by the natural substrate being not charcoal but rotting leaves, bark, and

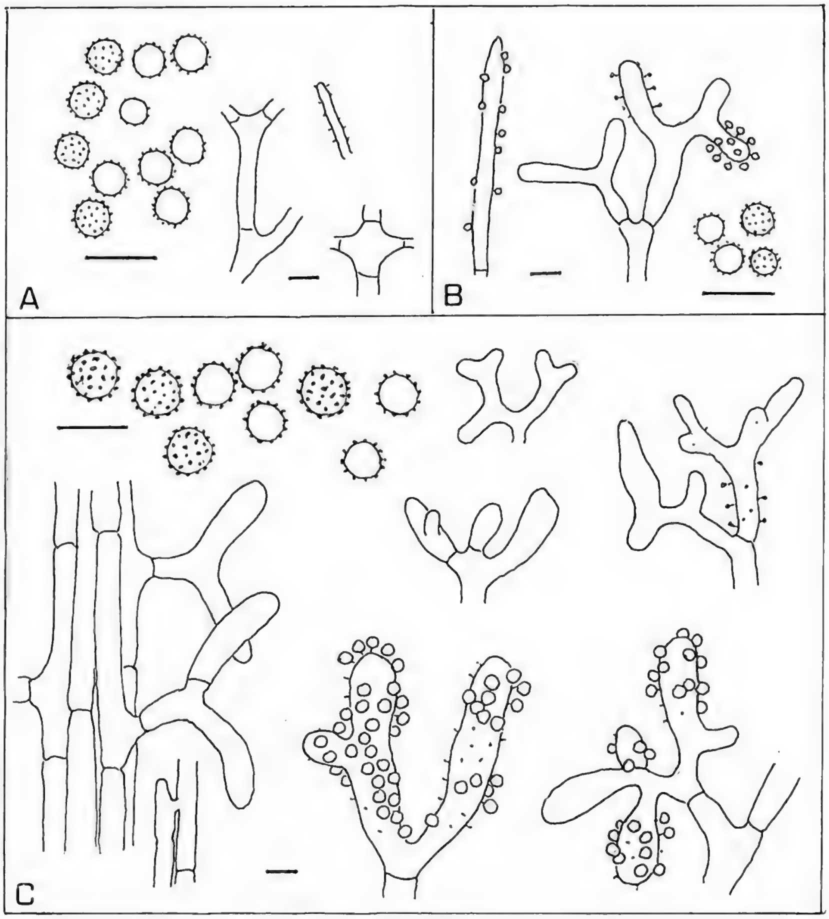


Plate 5. A ***Glischroderma cinctum*** (type): branched hyphae, collapsed conidiogenous hypha with denticles, and conidia; B ***Glischroderma* aff. *cinctum*** (herb. Rousseau): conidiogenous hyphae and conidia. C. ***Pachyphlodes pfisteri*** (CUP 62646–62651, mitosporic state): conidiogenous synnema, conidiogenous hyphae, and conidia. (Scale bars = 10 µm)

twigs under beech or oak, mosses, or fern. Beyond its microscopic similarity in *Chromelosporium*-like conidiogenesis and verrucose conidia, the species might remind of *Glischroderma* by the gel encrusting the superficial hyphae into a translucent membrane suggesting a peridium. That membrane should not be called a peridium, an ontogenically distinct structure of hyphae born with and covering the entire fertile body (*peri* = all around); the ontogeny of the gel membrane distinguishes it from *Glischroderma*. For that reason, I do not classify the *Pachyphlodes pfisteri* anamorph in *Glischroderma,* the name adopted by Korf (1994) and in CUP.

With its conidiogenous synnemata, *P. pfisteri* appears more closely related to the European *Chromelosporium terreste* (Fr.) M.B. Ellis.

Healy et al. (2015) published an illustrated description of the epigeous mitosporic mats of *Pachyphlodes pfisteri.* Another collection is illustrated here (Plate 4A, C).

Cultures, attempted by Korf, of broad hyphae on streptomycin CMA on 22 September 1994, grew rapidly, up to 2.5 cm in 10 days (Korf, handwritten notes). Conidia showed no sign of germination, as in some *Chromelosporium* species. For that reason, Healy et al. (2015) suggested that they might function as spermatia, germinating only in fertilizing ectomycorrhizal hypogeous hyphae.

The fresh collection of CUP material submitted by Korf for DNA analysis and published by Norman & Egger (1999), demonstrated a strong support for monophyly within *Pachyphloeus* and the *Scabropezia* clade in the *Pezizaceae.* This support was confirmed by Hansen et al. (2001), Tedersoo et al. (2006) and Læssøe & Hansen (2007). A refined phylogenetic study by Healy et al. (2013) of all known and undescribed taxa of *Pachyphloeus* Tul. & C. Tul., nom. illeg. [= *Pachyphlodes* Zobel] revealed the existence of 18 new taxa, two of which were fully described by Healy et al. (2015) as new species, *Pachyphlodes pfisteri* from North America and *P. nemoralis* from Europe.

Discussion

The classification of *Glischroderma* and *Ostracoderma* near *Chromelosporium* by Hennebert (1973) was based on the Malençon (1964) description of a Moroccan collection of *Glischroderma.* That observation on the genus *Glischroderma* incited Hennebert, also influenced by Juel (1920), to refer it to *Ostracoderma* and to synonymize *Lycoperdellon*, as no type existed for *Ostracoderma pulvinatum* and none of the terms of the original description suggested such interpretation.

Comparison of the original Latin descriptions (Table 1) clarifies the diagnosis. The only characters distinguishing *Glischroderma* from *Ostracoderma* are the circular hyphal subiculum and the viscosity of the mature fruit body, which justify the generic name and specific epithet (*cinctum*). The stickiness of fresh material observed by Fuckel was not seen by Fries.

Dried and with no traces of viscosity, the type material of *Glischroderma cinctum* could easily be identified as *Ostracoderma pulvinatum*, as has been done in herb. G, when no attention is drawn to the white circular subiculum

TABLE 1. Comparative descriptions of *Ostracoderma* and *Glischroderma*

Ostracoderma Fr. 1825 TYPE: *Ostracoderma pulvinatum* Fr. 1829	*Glischroderma* Fuckel 1870 TYPE: *Glischroderma cinctum* Fuckel 1870
PERIDIUM	
Rotundatum, rotundato-hemisphaericum	hemisphaericum
crustaceum, crustosum	persistens
—	in juvenili siccum, [deinde glutinosum]
—	tenax,
glabrum, laeve, minime villosum	furfuraceo-villosum, e floccis tenuissimis contextum
fragile, fragillissimum	in centro irregulariter fissum
in medio fatiscens, collabens, evanescens	dein in centro ampliatum, ore destituto
albidum	albidum, dein argillaceum
tenue, tenuissimum, ½ unc.	semi unciam diametro
thallus nullus conspicuus	basi mycelio tenuissime cinctum, cum annulo albo fribroso cinctum, e peridio juvenili represso orto
SPORIDIA	
coacervata, laxa, laxe coacervata	coacervata
floccis nullis intertexta	floccis destitutis
globosa	globosa; uniguttulata
argillacea	argillaceo-rubellis
minuta	minutissima, ca. 4 Mik. diam.

(apparently denied by Fries's words "thallus nullus conspicuus").

The words 'fatiscens', 'collabens', 'evanescens' suggest that Fries observed the fungus living. Such observation does not match either any central irregular splitting in *Glischroderma cinctum* and in *Lycoperdellon torrendii* (Bres.) Torrend or any central star-shaped opening to form a pore in *Glischroderma* aff. *cinctum*. In light of these reflections, *Ostracoderma* remains a mystery and the earlier proposed synonymy of *Lycoperdellon* with *Ostracoderma* (Hennebert 1973) should be regarded now as tentative and even doubtful.

Acknowledgements

My gratitude is to Richard P. (Dick) Korf for his constant friendship, guidance, and support during 44 professional years and later. I met Dick for the first time in Ottawa in 1960. He invited us, Lidwina and me, to his home along the Lake in Ithaca, in the summer 1961. At his door, when we arrived, we found the message "Welcome, come in, the house is yours, we come very soon, Dick." Surprising! In September 1969, we discussed days and nights the nomenclature of the pleomorphic fungi for the Kananaskis First Conference, about my distinction between botanical and anatomical nomenclature. I was greatly honored when, as Fulbright Scholar in 1972–73, he chose to stay with us at the University of Louvain. From our joint wishes exchanged between September 2 and December 10, 1973 in Ithaca, MYCOTAXON was planned and then born in September 1974. And so our working friendship continued. Many thanks to You, Dick!

I am also grateful to Dr Philippe Clerc of the Herbarium (G), and to herbarium curators Dr Scott LaGreca (CUP) and Dr A. Bogaerts (B). My sincere thanks are for Prof. Dr Rosanne Healy (University of Florida) and Prof. Dr Kathie Hodges (Cornell University) for their collaboration and the scientific revision of the manuscript. The help of Dr Cony Decock of MUCL, and of Dr Lorelei Norvell and Dr Shaun Pennycook of MYCOTAXON is also warmly acknowledged.

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